Conversion of a Micro-Jet Engine in a Shaft Engine in the Power Range 20 to 40 kW

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Motivation

The use of drones as unmanned aerial vehicles for private and commercial use is becoming increasingly important. Various technologies with their specific advantages and disadvantages are available for the propulsion of a drone: Electric motor, combustion engine, gas turbine. The gas turbine drive offers significant advantages over the combustion engine, at least in terms of torque over speed and vibration. In addition, the comparatively high weight of electric motors and batteries has a negative effect in every aviation application. A rough exploration of the market for small gas turbines showed, that in the power range from 20 to 40 kW no shaft power engines are available, while jet engines are available for higher power. As part of the FFG-funded exploratory project "JET 2 SHAFT", an existing jet engine is to be converted into a shaft power engine for the required power range. As basic engine the model *Olympus HP* of the company *AMT Netherlands* was chosen [1]. The main objectives of the project are a thermodynamic cycle calculation of the engine, the design of the shaft power turbine and the assessment of the effects of efficiency increasing measured on the overall system.

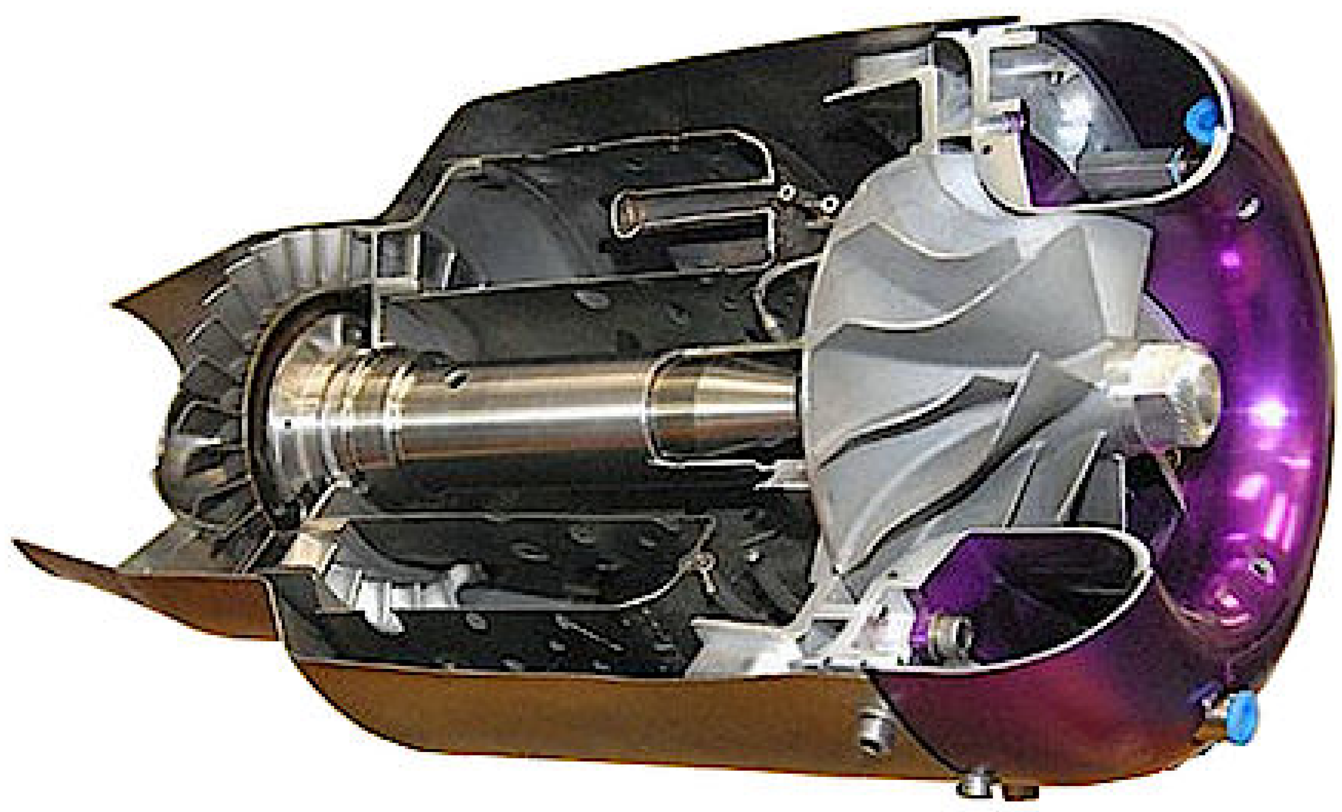

Fig. 1. Jet-engine Olympus HP [1]

Thermodynamic Cycle Model

For the design of the power turbine, its boundary conditions must be known. In the first step, a thermodynamic cycle process model of the selected jet engine is created and then extended by the power turbine. The two turbines are connected by an intermediate diffuser, which moves to the place of the jet engine nozzle within the conversion. The process model was created with the software *IPSE Pro*.

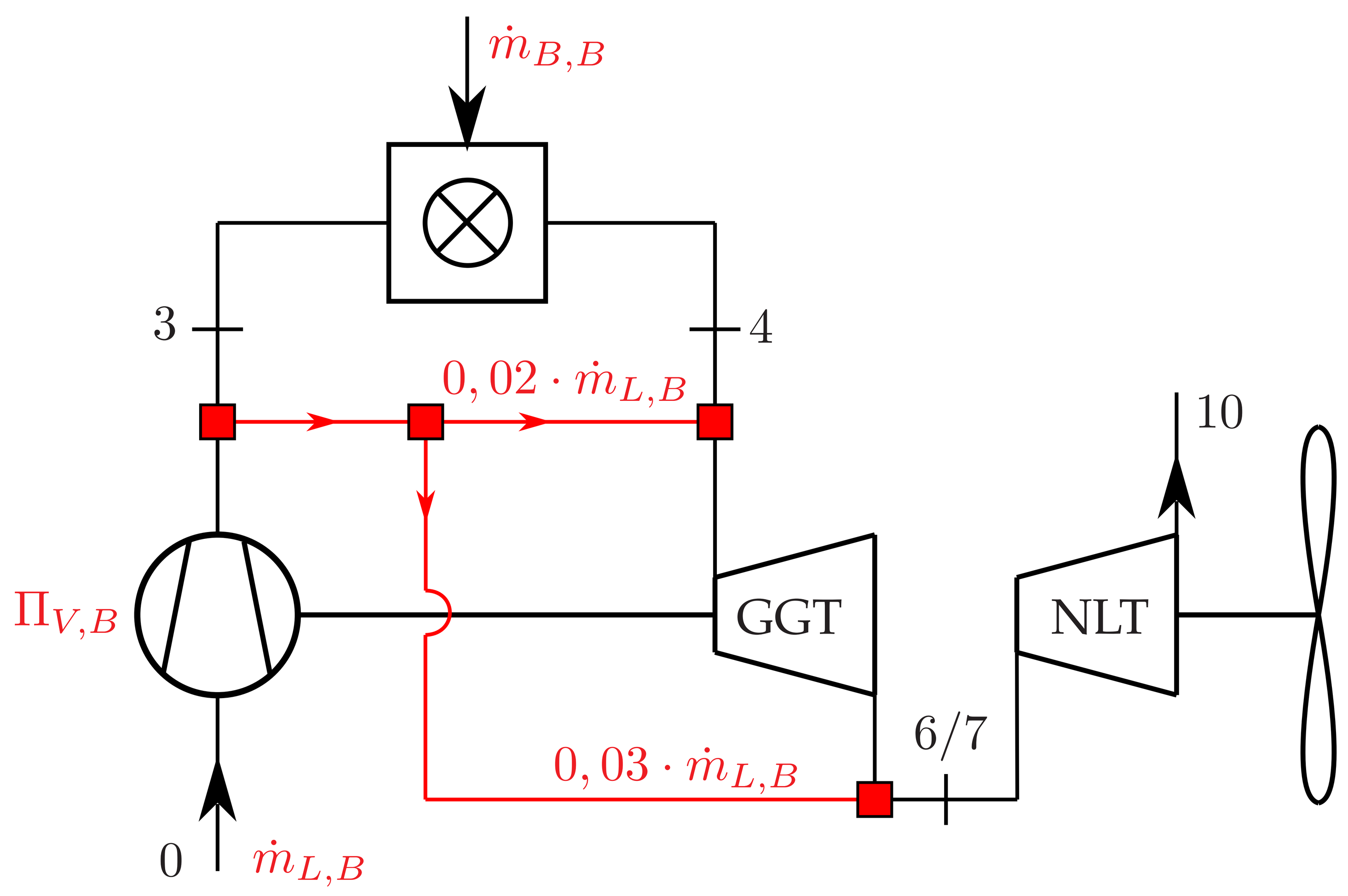

Fig. 2. Model of the shaft power engine

Power Turbine Design

With the help of the known boundary conditions resulting from the thermodynamic cycle process and the required output power, an analytical preliminary design of the power turbine was carried out. The assumed number of blades was then optimized for minimum total pressure loss by numerical calculations (Fig. 4). In addition, the profile shape was adapted to avoid flow separation and also to keep the pressure loss as low as possible.

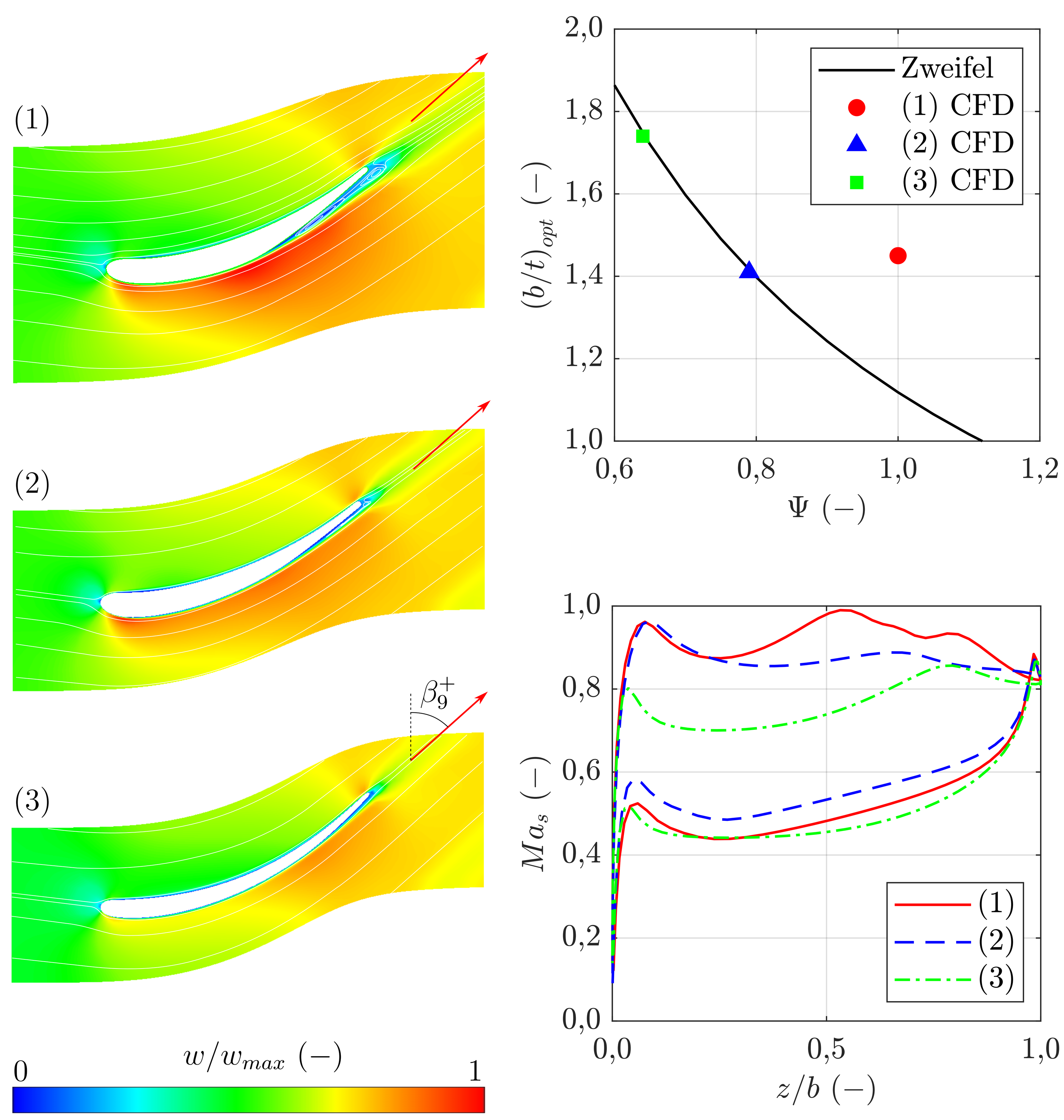

Fig. 3: Results of blade row optimization

The designed blade profile was then subjected to a structural analysis using finite element methods (FEM). In addition to the centrifugal load, the pressure distribution obtained from the CFD simulation was applied to the blade (Fig. 4). In addition, a modal analysis was performed to exclude resonances with the rotors rotational frequency.

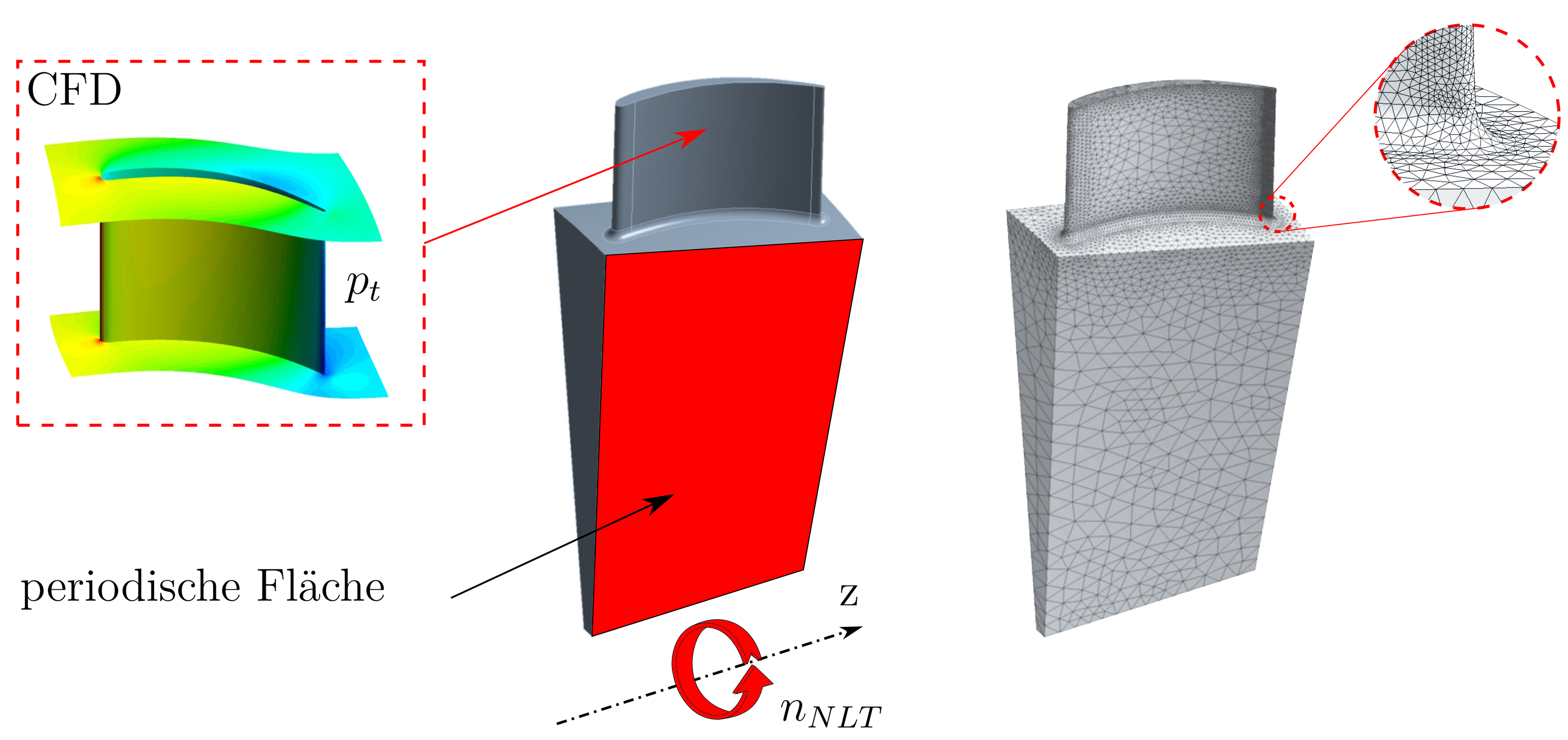

Fig. 4: Applied load for structural analysis

References

[1] AMT Netherlands. Olympus HP. *www.amtjets.com*, Stand: 03.10.2018.

Funding and Project Partners

FFG Österreichische Forschungsförderungsgesellschaft